REMARKS

This Amendment is filed in response to the FINAL Office Action mailed on July 2, 2002. All objections and rejections are respectfully traversed.

Claims were amended in response to the objections under 35 U.S.C. 112, second paragraph.

Claims 1, 2, 4-27, and 32-41 are pending in the application.

At Page 2 of the Office Action claims 34-36, 1, 12, 9, 15, 17 20, 27, 34, were rejected under 35 U.S.C. § 112, second paragraph. Amendments of the claims are believed to satisfy this rejection.

For claim 9, the Examiner asked where the initial estimates come from. Initial estimates are disclosed in Fig. 3 at block 300, and in the specification at page 11, lines 11-18.

For claim 15, the Examiner stated "it is not clear where the length of tape is located. How is the one or more reels related to the selected reel?"

Amendment of the claims addresses the relation between "one or more reels" and the selected reel.

The length of tape is given in the preamble of the claim 15 as:

"a length of tape on one or more reels", and so fixes "where the length of tape is", in response to the Examiner's question.

For claim 27, the Examiner states "steps e and f are not known."

Applicant respectfully urges that the steps e and f are fully disclosed in the specification, in Fig. 3 at block 310 the measurement error variance is computed. At block 316, in conjunction with block 314 and block 315, the measurement is discarded if it has unacceptable statistics, as determined by steps e and f, and as illustrated in blocks 314, 315, 316, and as discussed in the specification beginning at page 9 line 16 through page 11 line 4.

For claim 34, the Examiner states: "it is not clear how a variable which is a number is related to the steps of estimating. In step d, it is not clear of what is the individual measurement."

Applicant respectfully urges that a variable is a physical quantity, for example a angular position of a physical object. A measurement of the variable is then a number.

Amendment of claim 34 is believed to clear up which individual measurement is meant.

The Examiner states: "In all claims, it is not clear how the radius is calculated/estimated from just three angular position measurements, one measurement for each of three variables."

Applicant respectfully points out that the theory of the use of a Kalman filter is explained in the specification at page 5 line 1 through page 11 line 7. Details of the theory, as applied to the present invention are set out in the flowchart of Fig. 2a, Fig. 2B and Fig. 3.

As disclosed in the specification, a sequence of measurements is made as the angular positions of the various devices change, and these measurements are fed into a Kalman filter to estimate the current values of the variables. As set out in representative claim 1: "a processor . . . to calculate an updated estimate of one or both of a supply radius of a tape pack on said tape supply reel . . . a servo controller . . . to control rotation of said tape supply reel and said tape take-up reel."

At page 3 of the Office Action claims 1, 2, 4-27, and 32-41 were rejected under 35 U.S.C. 103(a) as being unpatentable over applicant's admitted prior art in view of Hermanns et al U. S. Patent No. 4,964,582 issued October 23, 1990 and Macchia U. S. Patent No. 4,399,953 issued August 23, 1983.

The present invention, as set out in representative claim 1 comprises, in part:

1. A system for measuring tape pack radii, comprising:
a tape supply reel, said tape supply reel rotating as a tape leaves said tape supply reel during a tape transfer process;
a tape take-up reel for receiving tape from said tape supply reel, said tape take-up reel rotating to receive said tape during said tape transfer process;
a first angular position transducer to measure an angular position of said tape supply reel;
a second angular position transducer to measure an angular position of said tape take-up reel;
a third angular position transducer to measure an angular position of a mechanical device, said mechanical device changing said angular position as said tape leaves said tape supply reel and is received by said tape take-up reel;
a processor having a Kalman filter, said Kalman filter responsive to one or both of an angular position measurement by said first angular position transducer and an angular position measurement by said second angular position transducer and also responsive to an angular position measurement by said third angular position transducer, to calculate an updated estimate of one or both of a supply radius of a tape pack on said tape supply reel and a take-up radius of a tape pack on said tape take-up reel;
a servo-controller, responsive to one or both of said supply radius and said take-up radius, to control rotation of said tape supply reel and said tape take-up reel.

Applicant's admitted prior art refers to pages 2-3 of the specification in the BACKGROUND section, and this section reads, in full as:

> Tape systems generally have two reels for storing tape, namely, a supply reel and a take-up reel, a capstan for moving the tape from reel to reel and tension arms for regulating the tape tension. High-performance tape systems also include servo systems, which regulate tape position and velocity. The servo systems rely on estimates of the tape pack radii to determine how to control the rotational speeds of the reels to achieve the desired tape velocity and position. The more accurate the estimates, the more precisely the servo system can control the movement of the tape.
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> Good estimates of the tape pack radii are fundamentally important in controlling all aspects of the system operations. For example, good estimates are important in determining from which reel to draw the tape to wrap around a scanner. An inaccurate estimate could result in an over-rotation of the selected reel. Further, good estimates are important to determining when to decelerate a high-speed rewind operation, again to avoid over-rotation of one of the reels that may result in the breaking of the tape of the detachment of the tape from the reel. Also, good estimates are important to determine if there is sufficient tape available on the supply reel to complete a record operation. Inaccurate estimates of the reel pack radii can result in incomplete record operations, if the system sufficiently under estimates the tape position.
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> In prior known systems the tape pack radius is calculated from measurements of the angular positions of the reels and the capstan. The position measurements are made by, for example, optical encoders that count the number of slots that pass between a photo detector and a light source as the reel rotates. The calculations produce results that are at best as accurate as the position measurements, which tend to be "noisy." With optical encoders, for example, the measurement noise is due in large part to quantitization errors. At slow speeds these systems tend to produce relatively inaccurate results because the position measurements are comparable to the quantitization errors.
>
> Certain prior systems have processed the noisy measurement using low-pass filters, in order to smooth them. However, this approach has two significant problems. First, the signals produced by these filters always lag behind the true tape pack radii, or in other words, the estimates are biased. Second, these filters are slow to converge. Moreover, there is an intrinsic tradeoff - the more the filter smooths the output signals, i.e., the estimates of the tape pack radii, the more lag is introduced into the system and the slower the convergence.

In the above quoted BACKGROUND text, Applicant simply points out that prior methods of calculating tape pack radius are deficient, for a plurality of reasons. Further, the text points out that better methods of calculating tape pack radius are needed.

The Hermanns patent describes a system for detecting bobbin circumference including both a drive drum (supply reel) and a take-up bobbin (take-up reel). The Hermanns system (Fig. 1) exclusively utilizes a rotational angle sensor located on the drive drum and a rotational angle sensor located on the take-up bobbin. See col. 8, lines 67-68 and col. 9, lines 1-5. Furthermore, Hermanns describes an apparatus that can calculate bobbin circumference from either a single angular position sensor located on the take-up bobbin or, alternately, calculates the value by combining data from the sensors on both the drive drum and the take-up bobbin. See col. 7, lines 28-34 and col. 8, lines 7-11. In this process, Hermanns uses a Kalman filter to estimate the tape-pack (bobbin) diameter indirectly by estimating initial diameter d_{0k} and tape (yarn) thickness δ_k first, and then performing additional processing steps to determine the desired result. See col. 4, lines 15-20 and col. 5, lines 1-2.

The Macchia patent describes a system for ensuring constant cable pay out velocity despite pay out sheave (supply reel) replacements performed as the cable is being unwound. Two storage idler rollers (idler reels) with variable separation maintain a controlled length of slack in the cable. When the supply reel is being replaced, the idler reels are drawn together, reducing the length of slack, and providing cable for payout. A single position sensor is utilized, responsive, to separation of the idler reels . See col. 2, lines 50-53. The Macchia patent suggest using a Kalman filter with data from this single sensor to estimate the velocity at which the idler reels are drawn together. See col. 5, lines 44-46.

Applicant respectfully urges that none of the cited art, Applicant's BACKGROUND section, Hermanns, nor Macchia, disclose Applicant's claimed novel use of a third angular position device to provide input to a Kalman filter, where the Kalman filter estimates tape pack radius of a supply reel or of a tape take up reel. That is, all cited art is completely absent a disclosure of Applicant's claimed novel "***a processor having a Kalman filter, said Kalman filter responsive to one or both of an angular position measurement by said first angular position transducer and an angular position measurement by said second angular position transducer and also responsive to an angular position measurement by said third angular position transducer***" along with the claimed ***servo-controller, responsive to one or both of said supply radius and said take-up radius, to control rotation of said tape supply reel and said tape take-up reel.***

Applicant respectfully urges that the cited art is legally precluded from rendering the claimed invention obvious under 35 U.S.C. 103 because of the total absence in any of the cited art of Applicant's claimed ***a processor having a Kalman filter, said Kalman filter responsive to one or both of an angular position measurement by said first angular position transducer and an angular position measurement by said second angular position***

transducer and also responsive to an angular position measurement by said third angular position transducer " along with the claimed ***servo-controller, responsive to one or both of said supply radius and said take-up radius, to control rotation of said tape supply reel and said tape take-up reel.***

Further, an analysis under *Graham v. Deere*, 383 U.S. 1, 148 U.S.P.Q. 459, (1966), and cited in MPEP 706.02 (m), comes to the same conclusion, that the claimed invention is novel and non-obvious. The three analytic criteria under *Graham v. Deer* are:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

Further, objective evidence present in the application indicating obviousness or nonobviousness is considered.

Using these analytic criteria, one then makes a legal determination as to whether or not a person of ordinary skill in the pertinent art would have found the claimed invention at the time that the invention was made.

First, the scope and content of the prior art is determined by reference to the cited three items, Applicant's Background statement, Hermanns, and Macchia. The scope and content of the prior art is summarized as:

A. Applicant's Background art mentions that tape pack radius is calculated in the past, and that the past methods are inadequate.

B. Hermanns discloses "a system for detecting bobbin circumference including both a drive drum (supply reel) and a take-up bobbin (take-up reel). The Hermanns system (Fig.

1) exclusively utilizes a rotational angle sensor located on the drive drum and a rotational angle sensor located on the take-up bobbin."

C. Macchia discloses "Two storage idler rollers (idler reels) with variable separation maintain a controlled length of slack in the cable. When the supply reel is being replaced, the idler reels are drawn together, reducing the length of slack, and providing cable for pay-out. A single position sensor is utilized, responsive, to separation of the idler reels."

2. The differences between the claimed invention and the cited art are, as set out in the claimed invention:

> ***a processor having a Kalman filter, said Kalman filter responsive to one or both of an angular position measurement by said first angular position transducer and an angular position measurement by said second angular position transducer and also responsive to an angular position measurement by said third angular position transducer,*** to calculate an updated estimate of one or both of a supply radius of a tape pack on said tape supply reel and a take-up radius of a tape pack on said tape take-up reel;
>
> ***a servo-controller, responsive to one or both of said supply radius and said take-up radius, to control rotation of said tape supply reel and said tape take-up reel.***

Applicant respectfully urges that none of the cited art show a processor having a Kalman filter, where the Kalman filter is ***responsive to one or both of an angular position measurement by said first angular position transducer and an angular position measurement by said second angular position transducer and also responsive to an angular position measurement by said third angular position transducer***

3. The level of ordinary skill in the art of tape drive design art can be ascertained by reference to Applicant's Background statement that the present methods of estimating tape pack radius are inadequate.

The level of ordinary skill in the art of Kalman filters can be ascertained from Hermans and Macchia as measuring at most two angular coordinates, and thereby estimating the

thread on a bobbin, or the cable played out on reels and sheaves. Nowhere is the use of three angular measurements mentioned in the cited art as input to a Kalman filter, for the estimation of either bobbin radius or amount of cable played out. Further, none of the cited patents mention any use of Kalman filters in estimating tape pack radius in a system having a tape supply reel and a tape take up reel.

Further, there is no mention, in Applicant's BACKGROUND section of a Kalman filter applied to the problem of estimating tape pack radius in a system having a tape supply reel and a tape take up reel.

Accordingly, the legal conclusion is forced, by the application of the *Graham v. Deere* analytic method, to be that a person of ordinary skill in the art of the cited art could not have found the present invention obvious, because of the absence of the claimed elements of the presently claimed invention in all of the cited art.

All independent claims are believed to be in condition for allowance.

All dependent claims are believed to be dependent from allowable independent claims, and therefore in condition for allowance.

Favorable action is respectfully solicited.

Please charge any additional fee occasioned by this paper to our Deposit Account No. 03-1237.

Respectfully submitted,

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MARK-UP PAGES FOR THE SEPTEMBER 3, 2002, AMENDMENT TO U.S. PATENT APPLICATION SER. NO. 09/441,003

The replacement for claim CLAIM resulted from the following changes:

1. (Amended) A system for measuring tape pack radii, comprising:

a tape supply reel, said tape supply reel rotating as a tape leaves said tape supply reel during a tape transfer process;

a tape take-up reel for receiving tape from said tape supply reel, said tape take-up reel rotating to receive said tape during said tape transfer process;

a first angular position transducer to measure an angular position of said tape supply reel;

a second angular position transducer to measure an angular position of said tape take-up reel;

a third angular position transducer to measure an angular position <u>of a mechanical device, said mechanical device changing said angular position as said tape leaves said tape supply reel and is received by said tape take-up reel</u> [in response to movement of said tape];

a processor having a Kalman filter, said Kalman filter responsive to one or both of an angular position measurement by said first angular position transducer and an angular position measurement by said second angular position transducer and also responsive to an angular position measurement by said third angular position transducer, to calculate an updated estimate of one or both of a supply radius of a tape pack on said tape supply reel and a take-up radius of a tape pack on said tape take-up reel;

a servo-controller, responsive to one or both of said supply radius and said take-up radius, to control rotation of said tape supply reel and said tape take-up reel.

12. (Amended) A method for estimating a length of tape on [a] at least one reel, comprising:

measuring a first angular position of a tape supply reel of said at least one reel;

measuring a second angular position of a tape take-up reel of said at least one reel;

measuring a third angular position in response to movement of [a] said tape; and,

estimating by a processor employing a Kalman filter said length of tape on [a] said at least one reel, in response to said first angular position of said tape supply reel, said second angular position of said tape take-up reel, and said third angular position in response to movement of said tape.

15. (Twice Amended) A method for estimating a length of tape on one or more reels, comprising:

measuring a first angular position of a tape supply reel of said one or more reels;

measuring a second angular position of a tape take-up reel of said one or more reels;

measuring a third angular position of a capstan engaging the tape;

measuring a fourth angular position of a tape tension arm;

selecting either said tape supply reel or said take-up reel as a selected reel; and,

estimating said length of tape by a processor employing a Kalman filter, said Kalman filter responsive to said angular position of said selected reel, said third angular position of said capstan, and said fourth angular position of said tape tension arm.

17. (Amended) A method for estimating the amount of tape on a tape reel [one or more], comprising:

measuring a first angular position of said [a] tape reel;

measuring a second angular position of a cylindrical member engaging and rotating with the tape as the tape moves along a tape path;

measuring a third angular position of a tension arm engaging the tape between said reel and said cylindrical member; and,

estimating how much tape is on said tape reel [and] by a processor employing a Kalman filter, said Kalman filter responsive to said first angular position of said tape reel, said second angular position of said cylindrical member, and said third angular position of said tension arm.

20. (Twice Amended) A system for measuring how much tape is on a reel from and to which tape is unwound and wound respectively during the rotation of the reel as the tape is moved along a tape path, comprising:

a cylindrical member engaging the tape at a position along the tape path that establishes a tape path length from the reel, said cylindrical member engaging said tape, said cylindrical member rotating [for rotation with the tape] as the tape is moved along the tape path;

a first angular position transducer for measuring a first angular position of said reel as the tape is moved along the tape path;

a second angular position transducer for measuring a second angular position of the cylindrical member as the tape is moved along the tape path; and

a processor including a Kalman filter responsive to the first and second angular positions measured by the first and second angular position transducers for calculating how much tape is on said reel.

34. (Amended) A method for estimating a length of tape on a reel, comprising:

a. choosing a variable to be measured, said variable related to estimating a length of tape on a reel;

b. selecting a minimum and maximum acceptable measurement value of said variable;

c. selecting a maximum acceptable variance of said variable;

d. recording an individual measurement of said variable;

e. determining if said individual measurement's variance is greater than said maximum acceptable variance;

f. determining if a three sigma-interval around said individual measurement is not at least partially included within an interval from said minimum to said maximum acceptable measurement values;

if the determinations in steps e OR f prove true, ignoring the individual measurement and basing the current Kalman filter estimate on other measurements and on previous Kalman filter estimates.

THE CLAIMS AS CURRENTLY PENDING ARE, AS FOLLOWS

1. A system for measuring tape pack radii, comprising:

a tape supply reel, said tape supply reel rotating as a tape leaves said tape supply reel during a tape transfer process;

a tape take-up reel for receiving tape from said tape supply reel, said tape take-up reel rotating to receive said tape during said tape transfer process;

a first angular position transducer to measure an angular position of said tape supply reel;

a second angular position transducer to measure an angular position of said tape take-up reel;

a third angular position transducer to measure an angular position of a mechanical device, said mechanical device changing said angular position as said tape leaves said tape supply reel and is received by said tape take-up reel;

a processor having a Kalman filter, said Kalman filter responsive to one or both of an angular position measurement by said first angular position transducer and an angular position measurement by said second angular position transducer and also responsive to an angular position measurement by said third angular position transducer, to calculate an updated estimate of one or both of a supply radius of a tape pack on said tape supply reel and a take-up radius of a tape pack on said tape take-up reel;

a servo-controller, responsive to one or both of said supply radius and said take-up radius, to control rotation of said tape supply reel and said tape take-up reel.

2. The apparatus as in claim 1, wherein said Kalman filter further comprises:

a supply Kalman filter responsive to said first angular position transducer and said third angular position transducer;

a take-up Kalman filter responsive to said second angular position transducer and said third angular position transducer.

4. The apparatus as in claim 1, further comprising:

a capstan, said tape contacting said capstan and said capstan rotating as said tape transfers from said tape supply reel to said tape take-up reel.

5. The apparatus as in claim 1, wherein said third angular position transducer further comprises:

an encoder responsive to an angular position of a capstan.

6. The apparatus as in claim 1 further comprising:

a tape length estimator responsive to said Kalman filter to determine the amount of tape available for a record operation.

7. A system for measuring a length of tape available for a record operation, comprising:

a tape supply reel, said tape supply reel rotating as a tape leaves said tape supply reel during a tape transfer process;

a tape take-up reel for receiving tape from said tape supply reel, said tape take-up reel rotating to receive said tape during said tape transfer process;

a first angular position transducer to measure an angular position of said tape supply reel;

a second angular position transducer to measure an angular position of said tape take-up reel;

a third angular position transducer responsive to movement of said tape;

a processor having a Kalman filter, said Kalman filter responsive to one or both of an angular position measurement by said first angular position transducer and an angular position measurement by said second angular position transducer and also responsive to an angular position measurement by said third angular position transducer, to determine an updated estimate of one or both of a supply radius of a tape pack on said tape supply reel and a take-up radius of a tape pack on said tape take-up reel for calculating said available length of tape; and

a servo-controller, responsive to one or both of said supply radius and said take-up radius, to control rotation of said tape supply reel and said tape take-up reel.

8. A method for estimating a radius of a tape on a supply reel and on a take-up reel, comprising:

measuring a first angular position of a tape supply reel;

measuring a second angular position of a tape take-up reel;

measuring a third angular position of a capstan that rotates to transfer the tape between said tape supply and take-up reels; and,

estimating by a processor employing a Kalman filter a radius of a tape pack on said supply reel and a radius of a tape pack on said take-up reel, in response to said first angular position of said tape supply reel, said second angular position of said tape take-up reel, and said third angular position of said capstan.

9. The method as in claim 8 wherein said estimating step by said processor having a Kalman filter further comprises:

responding to an initial estimate of said radius of a tape pack on said supply reel;

responding to an initial estimate of a radius of tape pack on said take-up reel; and,

responding to said first angular position measurement, said second angular position measurement, and said third angular position measurement to compute said radius of said tape pack on said supply reel and said radius of said tape pack on said take-up reel.

10. The method of claim 8 further comprising:

making said first angular measurement at a first regular time interval;

making said second angular measurement at a second regular time interval;

making said third angular measurement at a third regular time interval.

11. The method of claim 10 further comprising:

choosing said first regular time interval, said second regular time interval and said third regular time interval each to be approximately 20 milliseconds.

12. A method for estimating a length of tape on at least one reel, comprising:

measuring a first angular position of a tape supply reel of said at least one reel;

measuring a second angular position of a tape take-up reel of said at least one reel;

measuring a third angular position in response to movement of said tape; and,

estimating by a processor employing a Kalman filter said length of tape on said at least one reel, in response to said first angular position of said tape supply reel, said second angular position of said tape take-up reel, and said third angular position in response to movement of said tape.

13. The apparatus as in claim 1 wherein said first, second, and third angular position transducers further comprise:

a first, second, and third optical encoder responsive to the angular position of the supply reel, the take-up reel, and the third angular position transducer, respectively.

14. (Amended) A method for estimating a length of tape on a reel, comprising:

measuring a first angular position of a tape supply reel;

measuring a second angular position of a tape take-up reel;

measuring a third angular position of a capstan engaging the tape; and,

estimating said length of tape by a processor employing a Kalman filter, said Kalman filter responsive to at least one of said first angular position of said tape supply reel, said second angular position of said tape take-up reel, and said third angular position of said capstan.

15. (Amended) A method for estimating a length of tape on one or more reels, comprising:

measuring a first angular position of a tape supply reel of said one or more reels;

measuring a second angular position of a tape take-up reel of said one or more reels;

measuring a third angular position of a capstan engaging the tape;

measuring a fourth angular position of a tape tension arm;

selecting either said tape supply reel or said take-up reel as a selected reel; and,

estimating said length of tape by a processor employing a Kalman filter, said Kalman filter responsive to said angular position of said selected reel, said third angular position of said capstan, and said fourth angular position of said tape tension arm.

16. The method of claim 14 comprising:

measuring a fourth angular position of a tape engaging member which causes a change in the tape path length as tape is unwound from and wound onto the respective reel; and

the step of estimating by a processor employing a Kalman filter includes said Kalman filter being responsive to said fourth angular position of said tape engaging member as well as the measured first, second, and third angular positions.

17. A method for estimating the amount of tape on a tape reel, comprising:

measuring a first angular position of said tape reel;

measuring a second angular position of a cylindrical member engaging and rotating with the tape as the tape moves along a tape path;

measuring a third angular position of a tension arm engaging the tape between said reel and said cylindrical member; and,

estimating how much tape is on said tape reel by a processor employing a Kalman filter, said Kalman filter responsive to said first angular position of said tape reel, said second angular position of said cylindrical member, and said third angular position of said tension arm.

18. The method of claim 17 wherein the cylindrical member engages the tape to cause the tape to follow the tape path.

19. The method of claim 17 wherein the cylindrical member is a capstan that engages the tape and upon rotation causes the tape to move along the tape path.

20. A system for measuring how much tape is on a reel from and to which tape is unwound and wound respectively during the rotation of the reel as the tape is moved along a tape path, comprising:

a cylindrical member engaging the tape at a position along the tape path that establishes a tape path length from the reel, said cylindrical member engaging said tape, said cylindrical member rotating as the tape is moved along the tape path;

a first angular position transducer for measuring a first angular position of said reel as the tape is moved along the tape path;

a second angular position transducer for measuring a second angular position of the cylindrical member as the tape is moved along the tape path; and

a processor including a Kalman filter responsive to the first and second angular positions measured by the first and second angular position transducers for calculating how much tape is on said reel.

21 . The system as in claim 20 wherein the tape cylindrical member engages the tape to cause this tape to follow the tape path.

22. The system as in claim 20 wherein the tape cylindrical member is a capstan that engages the tape and upon rotation causes this tape to move along the tape path.

23. The system as in claim 20 further comprising:

a second member engaging the tape which causes a change in the tape path length from the reel to the position at which the cylindrical member engages the tape as the tape is moved along the tape path;

a third angular position transducer for measuring a third angular position of the second member as the tape is moved along the tape path; and

said processor calculating how much tape is on the reel in response to the third angular position measured by the third angular position transducer as well as the measured first and second angular positions.

24. The system of claim 23 wherein the second tape engaging member is a tension arm mechanism that engages tape at a position along the tape path between the reel and the cylindrical member.

25. A method for measuring how much tape is on a reel from and to which tape is unwound and wound respectively during the rotation of the reel as the tape is moved along a tape path, comprising:

measuring the amount of rotation by the reel as the tape is unwound from and/or wound onto the reel;

measuring the amount of movement of the tape along the tape path as the tape is unwound from and/or wound onto the reel, the movement of the tape measured at a position along the tape path that establishes a tape path length from the reel; and

calculating by a process that employs a Kalman filter how much tape is on the reel in response to the measured amount of rotation by the reel and the measured amount of movement of the tape.

26. The method of claim 25 further comprising:

measuring the amount of change in the tape path length as the tape is unwound from and/or wound onto the reel; and

said step of calculating how much tape is on the reel is in response to the measured amount of change in the tape path length as well as the measured amounts of reel rotation and tape movement.

27. The method of claim 25 further comprising:

a. choosing a variable to be measured;

b. selecting a minimum and maximum acceptable measurement value of said variable;

c. selecting a maximum acceptable variance of said variable;

d. recording an individual measurement;

e. determining if said individual measurement's variance is greater than said maximum acceptable variance;

f. determining if a three sigma-interval around said individual measurement is not at least partially included within an interval from said minimum to said maximum acceptable measurement values;

g. if the determinations in steps e OR f prove true, ignoring the individual measurement and basing the current Kalman filter estimate on other measurements and on previous Kalman filter estimates.

32. The apparatus as in claim 1 wherein said third angular position transducer further comprises:

an encoder responsive to an angular position of a supply reel tension arm.

33. The apparatus as in claim 1 wherein said third angular position transducer further comprises:

an encoder responsive to an angular position of a take-up reel tension arm.

34. A method for estimating a length of tape on a reel, comprising:

a. choosing a variable to be measured, said variable related to estimating a length of tape on a reel;

b. selecting a minimum and maximum acceptable measurement value of said variable;

c. selecting a maximum acceptable variance of said variable;

d. recording an individual measurement of said variable;

e. determining if said individual measurement's variance is greater than said maximum acceptable variance;

f. determining if a three sigma-interval around said individual measurement is not at least partially included within an interval from said minimum to said maximum acceptable measurement values;

if the determinations in steps e OR f prove true, ignoring the individual measurement and basing the current Kalman filter estimate on other measurements and on previous Kalman filter estimates.

35. A method for estimating a length of tape on a reel, comprising:

a. choosing a variable to be measured, said variable related to estimating a length of tape on a reel;

b. selecting a minimum and maximum acceptable measurement value of said variable;

c. selecting a maximum acceptable variance of said variable;

d. recording an individual measurement;

e. determining if said individual measurement's variance is greater than said maximum acceptable variance;

if the determination in step e proves true, ignoring the individual measurement and basing the current Kalman filter estimate on other measurements and on previous Kalman filter estimates.

36. A method for estimating a length of tape on a reel, comprising:

a. choosing a variable to be measured, said variable related to estimating a length of tape on a reel;

b. selecting a minimum and maximum acceptable measurement value of said variable;

c. selecting a maximum acceptable variance of said variable;

d. recording an individual measurement;

e. determining if a three sigma-interval around said individual measurement is not at least partially included within an interval from said minimum to said maximum acceptable measurement values;

if the determination in step e proves true, ignoring the individual measurement and basing the current Kalman filter estimate on other measurements and on previous Kalman filter estimates.

37. The method of claim 34 or claim 35 or claim 36 further comprising:

choosing as said variable an angular position of said reel.

38. The method of claim 34 or claim 35 or claim 36 further comprising:

choosing as said variable an angular position of a second reel upon which said tape is wound.

39. The method of claim 34 or claim 35 or claim 36 further comprising:

choosing as said variable an angular position of a transducer, said transducer responsive to movement of said tape.

40. The method of claim 39 further comprising:

choosing said transducer to measure angular position of a capstan, said tape in contact with said capstan, said capstan rotating as said tape moves.

41. The method of claim 39 further comprising:

choosing said transducer to measure an angular position of a tension arm in contact with said tape.